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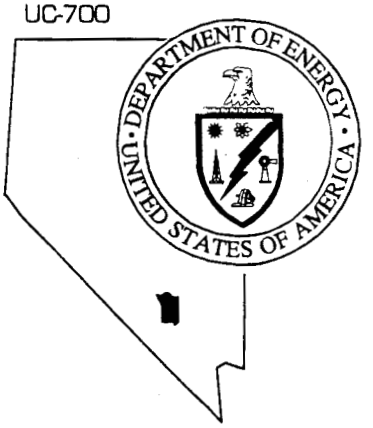

Verification Sampling and Analysis Plan for Sediment and Water Sampling Rulison Drilling Effluent Pond

July 1996

Environmental Restoration
Division

U.S. Department of Energy
Nevada Operations Office

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COPY

VERIFICATION SAMPLING AND ANALYSIS PLAN FOR SEDIMENT AND WATER SAMPLING RULISON DRILLING EFFLUENT POND

DOE Nevada Operations Office
Las Vegas, Nevada

July 1996

VERIFICATION SAMPLING AND ANALYSIS PLAN
FOR SEDIMENT AND WATER SAMPLING
RULISON DRILLING EFFLUENT POND

Approved by: Janet Appenzeller-Wing Date: 7/1/96

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List of Acronyms and Abbreviations

AR/COC	Analysis Request and Chain of Custody
BTEX	Benzene, toluene, ethylbenzene, xylene
CAP	Corrective Action Plan
COC	Contaminant of concern
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
ESSC	Environmental Services Support Contractor
FAC	Field Activities Coordinator
ft	Foot (feet)
m	Meter(s)
mℓ	Milliliter(s)
MS/MSD	Matrix Spike and Matrix Spike Duplicate
QAPP	Quality Assurance Project Plan
QC	Quality control
RCRA	Resource Conservation and Recovery Act
SSHASP	Site-Specific Health and Safety Plan
TCLP	Toxicity Characteristic Leaching Procedure
TDS	Total dissolved solid
TPH	Total petroleum hydrocarbon
VSAP	Verification Sampling and Analysis Plan
VOA	Volatile organic analysis
yd^3	Cubic yard(s)
°C	Degree(s) Celsius

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1.0 Introduction

The purpose of this Verification Sampling and Analysis Plan (VSAP) is to provide guidance for collecting and analyzing soil, water, and sediment samples during the remediation of the Rulison Site drilling effluent pond. This plan provides guidance for activities associated with the collection of

- water samples prior to, during, and following pond drainage and construction dewatering
- stabilized sediment samples prior to shipment to a disposal landfill
- water samples from the pond water which must be treated prior to discharge
- soil samples from under the former pond sediments to verify clean closure of the pond.

1.1 Project Description and Background

Project Rulison was a joint U.S. Atomic Energy Commission and Austral Oil Company experiment conducted as part of the Plowshare Program. The experiment was conducted to test the feasibility of using a nuclear device to increase natural gas production in low-permeability, gas-producing geologic formations. The experiment was conducted on September 10, 1969, and consisted of detonating a 40-kiloton device at a depth of 2,568 meters (m) (8,426 feet [ft]) below the ground surface. Production testing of the well was conducted in 1970 and 1971. The site was cleaned up in 1972 with a final cleanup conducted after the testing wells were plugged in 1976. Some surface contamination resulted from decontamination of drilling equipment and fallout from the gas flaring (DOE, 1988). Except for cleanup of the drilling effluent pond, all surface contamination was removed during site clean-up operations.

The site is situated on the north slope of Battlement Mesa on the upper reaches of Battlement Creek, at an elevation of approximately 2,500 m (8,200 ft). The valley is open to the north-northwest and is bounded on the other three sides by steep mountain slopes that rise to elevations above 2,927 m (9,600 ft). The drilling effluent pond is triangular in shape and covers approximately 0.5 acre. It is approximately 6 m (20 ft) deep from the top of the berm to the pond bottom and is located approximately 400 m (1,312 ft) north-northwest of the original surface ground zero well. The pond originally contained drilling fluids, but was converted to a fresh-water trout pond. The pond was left in place at the request of the land owner (ERDA, 1977) and contains aquatic vegetation, tiger salamanders *(Ambystoma tigrinium)*, and stocked rainbow trout. The pond is fenced to prevent access to wildlife and livestock.

1.2 Previous Studies

The drilling effluent pond at the Rulison Site was used to store nonradioactive drilling wastes resulting from drilling of the device emplacement hole (Well R-E). Cuttings and most of the drilling fluid were excavated, transported off site, and properly disposed in 1976; however, some residual fluid was left in the pond. The drilling fluids consisted of a bentonitic drilling mud with various additives used to improve drilling characteristics, such as diesel fuel and chrome lignosulfonate. In 1994 and 1995, three pond-sediment sampling events were conducted to evaluate the nature of this residual drilling fluid. Surface water, soil, and sediment samples were collected. All analytical results of surface water samples were clean, with no petroleum compounds or metals present. The results of the sampling events are presented in the Rulison Site Corrective Action Plan (CAP) (DOE, 1995a) and in Tables 5-1 through 5-6. Also included are state of Colorado and federal clean-up standards for heavy metals and organic compounds in soils. Colorado discharge standards for water are site-specific and will be specified in the water discharge permit.

1.3 Sampling Objectives and Approach

There are four objectives of this sampling and analysis event. First, samples of pond water will be collected before, during, and following pond drainage activity to verify that the discharge water is not contaminated. Also, samples of water produced during construction dewatering activities, if necessary, will be also sampled to verify that discharged water was not contaminated. Second, samples of stabilized sediment will be collected to verify that the sediment complies with the landfill waste acceptance criteria following stabilization. Third, it is anticipated that as water drainage from the pond nears completion, the water will become mixed with contaminated sediment and will have to be stored on site in frac (Baker) tanks, treated, and then discharged. This water will be sampled prior to discharge to verify that treatment process effectiveness meets all federal and state discharge standards. Finally, representative samples of soil from underneath the drilling effluent pond will be collected to verify that all contaminated sediment from the bottom of the pond was removed during pond remediation and that constituents of concern from the pond did not contaminate the underlying soil.

The proposed approach for sampling of water drained from the pond and discharged during construction dewatering will be as follows:

- Water will be drained from the pond into the nearby stream until the water level in the pond has been reduced as much as possible as specified in the CAP (DOE, 1995a).

- If construction dewatering is necessary, this produced water will also be discharged to the same nearby stream.

- Water samples will be collected at frequencies as specified in Chapter 5.0 of this VSAP, utilizing approved contractor procedures and will be analyzed according to methods specified in the Rulison Site Quality Assurance Project Plan (QAPP) (DOE, 1995b).

- Water samples will be collected prior to and in the initial stages of drainage to provide the baseline for which subsequent samples will be compared.

- Additional water samples will be collected at the midpoint of pond drainage and again near the end of pond drainage.

- Water samples will be analyzed for whole effluent toxicity; total Resource Conservation and Recovery Act (RCRA) metals; total petroleum hydrocarbons (TPH) as diesel; and benzene, toluene, ethylbenzene, and total xylenes (BTEX).

The proposed approach for sampling of sediment following stabilization and prior to shipment to the designated landfill will be as follows:

- A large, truck-mounted pug mill will be used for mixing the sediment with the proprietary stabilizer, as specified in the Rulison CAP (DOE, 1995a).

- Samples of stabilized sediment will be collected at regular intervals during the stabilization process using approved contractor procedures.

- Stabilized sediment samples will be analyzed for Toxicity Characteristics Leaching Procedure (TCLP) chromium, TPH (diesel), and TCLP Benzene, according to methods defined in the Rulison Site QAPP (DOE, 1995b).

- Specific information regarding sampling and analysis stabilized sediments is provided in Section 5.0.

The proposed approach for sampling water that may have become mixed with contaminated sediment following removal from the pond will be as follows:

- All potentially contaminated water will be stored on site during the final stages of removal from the pond in frac (Baker) tanks.

- This water will be treated and discharged directly if it passes the discharge criteria. The water will not be discharged until it meets state and federal water quality standards.

- Samples of the treated water will be collected using approved contractor procedures.

- Treated water samples will be analyzed for total RCRA metals, TPH (diesel), and BTEX, according to methods defined in the Rulison Site QAPP (DOE, 1995b).

- Specific information regarding sampling and analysis of potentially contaminated water is provided in Section 5.0.

The proposed approach for collecting samples of soil from underneath the former pond will be as follows:

- During or following the removal of all remaining water and sediment from the pond (depending on site conditions), the ground surface will be sampled at frequencies specified in Chapter 5.0 of this VSAP to verify that all contaminated sediment from the bottom of the pond was removed during pond reclamation and that constituents of concern from the pond did not contaminate underlying soil.

- The frequency and locations of soil samples will be selected according to guidance provided by *Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media* (EPA, 1989a); *Verification of PCB Spill Cleanup By Sampling and Analysis* (EPA, 1985); *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989b); and *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (EPA, 1992).

- The soil samples will be collected using approved contractor procedures.

- Soil samples will be analyzed for total TCLP RCRA metals, TPH (diesel), and BTEX, according to methods defined in the Rulison Site QAPP (DOE, 1995b).

- If the analytical results of a particular sample are above the regulatory limit, additional soil shall be removed from that sampling location until the state of Colorado soil clean-up standard is met.

1.4 Project Schedule

The proposed target starting date for field activities is July 1995. The field activities are expected to last 90 working days. Pending review and approval of this VSAP, sampling activities will be definitively scheduled. The target date for completion of this project is September 30, 1995.

1.5 Document Ownership

The U.S. Department of Energy (DOE), Nevada Operations Office (DOE/NV), Nevada Environmental Restoration Project, is the owner of this VSAP. This department is responsible for initiating the document review process; the Environmental Services Support Contractor

(ESSC) is responsible for incorporating or resolving reviewer comments and concerns into the final plan. Questions or comments concerning this document should be addressed to the DOE/NV Rulison Site Manager and/or the ESSC Project Manager.

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2.0 Project Organization and Responsibilities

The ESSC is tasked with managing the verification sampling and analysis activities. The duties of organizations and individuals participating in the off-site background sample collection effort are outlined below.

2.1 Duties

The DOE Rulison Site Manager has the following duties:

- Requests and allocates resources for Rulison Site activities
- Coordinates Rulison Site activities
- Ensures that sampling and analytical activities be conducted in accordance with DOE guidelines, as well as with other applicable state and federal regulations
- Responds to recommendations from audits and assessments of the Rulison Site
- Reviews and approves plans necessary to control the quality of sampling and analytical data.

The ESSC Project Manager has the following duties:

- Arranges for preparation, review, and approval of the VSAP; distributes the approved VSAP; and revises the VSAP, as needed
- Arranges for an Industrial Hygiene representative to review proposed sampling activities and a Site-Specific Heath and Safety Plan (SSHASP)
- Provides for the analytical cost estimation and budget preparation for sampling and analytical activities
- Assigns a qualified analytical laboratory
- Tracks analytical invoice and processing coordination for payment
- Interfaces and resolves problems between the field and the laboratory
- Conducts quality control (QC) check of all field documentation
- Notifies all relevant personnel of sampling schedules and ensures that entry into the site is arranged

- Oversees the implementation of this VSAP
- Evaluates project changes, nonconformances, and corrective actions and notifies affected personnel
- Ensures that original copies of all field forms, chain of custody and request for analysis records, analytical data, sample collection, and equipment maintenance logs are entered into document control
- Assesses analytical data generated under this VSAP.

Sampling will be conducted by a field crew consisting of a Field Activities Coordinator (FAC) and sampling personnel. The FAC is the on-site representative and is responsible for the following:

- Scheduling analytical services
- Procuring sampling equipment and containers
- Developing, maintaining, and implementing the approved SSHASP
- Providing day-to-day management of the sampling team
- Supervising sample collection
- Reviewing all field documentation
- Packaging, transporting, and shipping samples to the laboratory
- Tracking sample information (for sample number, chain of custody number, request for analysis number, sample type [e.g., soil and water], contract laboratory, shipping date, sample location, project contact, and priority of sample)
- Monitoring QC analyses performed by the laboratory
- Verifying laboratory analytical reports
- Overseeing field site control
- Ensuring that sampling personnel have proper documentation of appropriate Health and Safety training while in the field
- Maintaining field notes
- Reporting nonconformances and perform corrective actions.

The ESSC Health and Safety Officer is responsible for the following:

- Reviewing the SSHASP
- Providing field activities oversight, as needed.

The Analytical Laboratory is responsible for the following:

- Preparing and analyzing samples
- Maintaining chain of custody documentation
- Validating initial data
- Reporting nonconformances and perform corrective actions
- Reporting data
- Submitting data summary packages that meet data quality requirements.

2.2 Personnel Training and Qualifications

Prior to conducting sample collection activities, field personnel must complete health and safety training for hazardous waste workers that conforms to U.S. Occupational, Safety, and Health Administration requirements found in Title 29 Code of Federal Regulations §1910.120(E). Sampling team members must demonstrate knowledge of sampling procedures and equipment operation, in accordance with the Rulison Site QAPP, gained through documented formal training and/or on-the-job experience. Health-related qualifications include initial and periodic physical examinations.

Prerequisite general hazards training for soil sampling shall include instruction in employee right-to-know issues, chemical and physical hazards associated with sampling, and safe work practices. General hazards training shall be repeated annually for each employee. No other specialized safety training is required for persons working under this VSAP.

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3.0 Data Quality Objectives

Data Quality Objectives (DQO) are qualitative and quantitative statements derived from the outputs of the DQO planning process. The DQO process is a series of planning steps designed to ensure that the type, quantity, and quality of environmental data used in decision making is appropriate for the intended application (EPA, 1993). The DQO process, for the purposes of this project, can be divided into four major elements: a statement of sample collection objective(s), DQO development, an analytical data assessment, and the development of a VSAP that satisfies the DQOs.

Data Quality Objectives have been established to define the data quality requirements necessary to meet the project objectives stated in Section 1.1.2 of this VSAP. Chemical analysis of soils will meet the DQO guidance criteria presented in *Data Quality Objectives for Remedial Response Activities, Development Response* (EPA, 1987a).

3.1 Sample Collection Objectives

The main objectives of this sample collection project are presented in Section 1.1.2 of this VSAP.

3.2 Analytical Data Assessment

Chemical data used for this project will be consistent with the U.S. Environmental Protection Agency (EPA) data verification and validation procedures outlined in SW-846 (EPA, 1987b). Sample analysis data will be assessed using the following indicators:

- Laboratory quantitation limits
- Laboratory analysis bias
- Laboratory analysis precision
- Data completeness
- Sample representativeness
- Data comparability

3.3 Laboratory Quantitation Limits

Chapter 4.0 provides laboratory quantitation limits expected for this task. Failure to attain these limits may result in the conditional acceptance or rejection of analytical data.

3.4 Laboratory Analysis Bias

Bias acceptance criteria will be reported by the laboratory in the analytical data report for each analyte allowing for evaluation of the control sample results. Control sample acceptance criteria are defined as plus or minus three standard deviations from the mean percent recovery of at least 20 laboratory control samples. Laboratory prepared method blanks are used to monitor bias from contamination introduced during analytical procedures. Positive values for method blanks can qualify analytical results in the associated investigatory samples indicating false positive results.

3.5 Laboratory Analysis Precision

Precision is assessed by means of duplicate or replicate sample analysis. For this project, precision will be measured through analysis of duplicate laboratory control samples. Precision is monitored by the laboratory in the same way as bias. Precision acceptance criteria will be included in the analytical data report for evaluation of analytical precision.

3.6 Data Completeness

The data completeness goal for this project is 80 percent because of the limited number of samples from a given location.

3.7 Sample Representativeness

Duplicate samples will be collected to document sampling representativeness. If analyses results for the sample and its duplicate do not differ substantially, the sampling method will be determined sufficient and the samples representative.

4.0 Quality Control

Quality control for sampling at all locations will be implemented to ensure that the measurement data collected meet the DQOs for this investigation. Quality control will be implemented by strict adherence to the sampling procedures described in Chapters 5.0 and 6.0 of this plan; documenting the sampling activities and sample custody; using standard equipment and materials; and collecting, analyzing, and evaluating field and laboratory QC samples. Field and laboratory QC shall be maintained and documented in accordance with the Rulison Site QAPP. Specific activities are outlined below.

4.1 Field Quality Control

Sample collection will be performed in strict accordance with this VSAP and approved contractor procedures. Samples will be collected in properly cleaned, laboratory-prepared containers, using equipment that has been properly decontaminated. Field QC samples will be collected as indicated below.

4.2 Field Duplicate Samples

Duplicate environmental samples will be collected at a rate of 10 percent of the original samples and analyzed for the same suite of analytes to assess subsample variability. Environmental duplicates will not be taken from the same locations as the matrix spike and matrix spike duplicate (MS/MSD) samples.

4.3 Matrix Spike and Matrix Spike Duplicate Samples

Matrix spike and matrix spike duplicate samples will be requested at a rate of 5 percent of the number of environmental samples and analyzed to determine interferences of the sample matrices on the analytical methods and subsample variance of the composite samples. The MS/MSD samples will not be specified from the same location as the duplicate samples. The MS/MSD aliquots shall be taken from each environmental sample designated by the field supervisor on the Analysis Request and Chain of Custody (AR/COC) Record.

4.4 Equipment Rinsate Blank Samples

Equipment rinsate blanks will be collected at a rate of 10 percent of the number of environmental samples and analyzed for the same suite of analytes as the samples. Equipment rinsate samples will be collected immediately following final decontamination of the sampling device.

4.5 Trip Blank Samples

Trip blank samples will be used during the project to document the occurrence of contamination of samples during transport to the analytical laboratory. The trip blanks will be prepared by the laboratory and shipped to the site with the sample containers. Trip blanks will consist of two 40-milliliter (mℓ) glass volatile organic analysis (VOA) vials filled with deionized water at the laboratory. One set of trip blanks will accompany each shipping cooler with BTEX samples. These samples will be subjected to the same sample management and documentation procedures as the environmental BTEX samples.

4.6 Field Blank Samples

One deionized-water field blank will be collected from each source of deionized water used during the project to verify the decontamination water chemistry. The sample will be collected by pouring deionized water directly into the appropriate sample bottles. These samples will be subjected to the same sample management and documentation procedures as the environmental samples.

4.7 Laboratory Quality Control Samples

Laboratory QC will be maintained in accordance with the Rulison Site QAPP using the standard procedures established by the laboratory. Method blank, laboratory control sample, and laboratory-control-sample duplicate samples will be analyzed and used to evaluate method and instrumental accuracy and precision.

4.8 Calculation of Data Quality Indicators

Analytical data quality will be assessed in part using the indicators for bias, precision, and completeness in accordance with procedures specified in the Rulison Site QAPP.

5.0 Sampling Strategy and Sampling Locations

Sampling activities will be conducted according to the sampling strategy, methodology, and sampling locations selected as detailed below. Samples will be collected using approved contractor procedures. All sample collection activities shall be thoroughly documented on the Sample Collection Log for each sample. Daily activities shall be recorded sequentially on a Field Activity Daily Log.

Following verification sampling activities, the remainder of site restoration activities will be completed as part of the Rulison CAP (DOE, 1995a).

5.1 Selection of Sampling Frequency and Sampling Locations

The rationale and approaches outlined below were used for determining optimal sampling frequency and locations for each of the sampling tasks of this project.

5.2 Water Samples prior to, during, and following Pond Drainage, and during Construction Dewatering

The goal of this sampling task is to verify that the water being drained into the nearby stream is not contaminated from the sediment remaining in the bottom of the pond or that water discharged as part of construction dewatering activities is not contaminated. Sample analytical results will be compared to the state of Colorado water clean-up standards specified in the discharge permit to verify that discharge criteria have been met. The following approach will be used:

- One sample will be collected from the pond prior to initiating discharge and will be analyzed for Whole Effluent Toxicity.
- One sample will be collected at the beginning of pond drainage activity, and analyzed for total lead, chromium, and barium, according to the methods cited in the Rulison Site QAPP for this project (DOE, 1995b).
- At the midpoint of draining the pond, one sample will be collected for suspended solids; total dissolved solids (TDS); TPH (diesel); and BTEX. Samples will be analyzed according to methods defined in the Rulison Site QAPP.
- At the end of pond drainage activity, one sample will be collected for TDS, TPH (diesel), and BTEX. Samples will be analyzed according to methods defined in the Rulison Site QAPP.

In addition, discharged water samples shall be collected and analyzed during pond clean-up operations at the discretion of the site supervisor in the event that site conditions change or additional water-quality information is required. Appropriate QC samples shall be collected along with these water samples in accordance with the Rulison Site QAPP.

5.3 Stabilized Sediment Samples

The goal of this sampling task is to verify the concentrations of constituents of concern in the sediment following stabilization for the purposes of determining whether the stabilized sediment represents a hazardous waste. Analytical results will be provided to the Colorado Department of Health and the Environment and to a specified landfill owner/operator, for a hazardous or nonhazardous determination prior to anticipated disposal at the landfill. Approximately 3,000 cubic yards (yd^3) of stabilized sediment will be produced, depending on the final method of stabilization. Samples of stabilized sediment will be collected as the sediment is prepared for shipment to the specified landfill for disposal. Ten samples of the stabilized sediment will be collected, corresponding to an approximate rate of 1 sample for every 300 yd^3 of stabilized sediment. Samples will be collected according to approved contractor procedures. Samples will be analyzed for TCLP chromium, TPH (diesel), and TCLP Benzene according to methods specified in the Rulison Site QAPP (DOE, 1995b), for the purposes of comparison with the unmodified sediment sample results.

5.4 Treated Pond Water Samples

The goal of this sampling task is to verify that water, drained from the pond, but contained on site in frac (Baker) tanks, meets federal and state discharge criteria following treatment. The treatment methodologies are specified in the Rulison CAP (DOE, 1995a). Following treatment, two water samples will be collected from each container of treated water to test for discharge criteria. The samples will be collected using approved contractor procedures. The samples will be analyzed for total RCRA metals, TPH (diesel), and BTEX according to methods specified in the Rulison Site QAPP (DOE, 1995b). Sample analytical results will be compared to state of Colorado water clean-up standards specified in the discharge permit to verify that discharge criteria have been met.

5.5 Verification Soil Samples

The goal of this sampling task is to acquire representative samples of soil from underneath and adjacent to the drilling effluent pond to verify that all contaminated sediment from the bottom of the pond was removed during pond remediation and that constituents of concern from the pond did not contaminate underlying soil. A statistical approach based on EPA guidance is used;

however, due to the lack of information about the nature and extent of contaminants of concern (COC) in soils below the pond sediments, the number of proposed soil samples estimated below is conservative and may be modified based on actual site conditions.

The frequency and locations of soil samples will be selected according to guidance provided primarily by *Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media* (EPA, 1989a), and by *Verification of PCB Spill Cleanup By Sampling and Analysis* (EPA, 1985). Additional statistical guidance will be obtained from *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Interim Final Guidance* (EPA, 1989b), and *Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities, Addendum to Interim Final Guidance* (EPA, 1992).

A systematic sampling approach will be used to assess the occurrence of any soil contamination. This approach is chosen to distribute the samples more uniformly over the site. Because the sample points follow a simple pattern and are separated by a fixed distance, locating the samples points in the field will be easier than if a random approach was selected. This method will also minimize the possibility that more contaminated areas of the site will not be represented in the sample (EPA, 1989c). The soil samples will be collected using approved contractor procedures. All soil samples will be analyzed for TPH (diesel) and BTEX. In addition, samples will be analyzed for TCLP RCRA metals at the rate of 20 percent of the TPH and BTEX samples. Samples will be analyzed according to methods defined in the Rulison Site QAPP (DOE, 1995b). Sample analytical results will be compared to state of Colorado soil clean-up standards to verify that clean-up criteria have been met. If the analytical results of a particular sample are above the regulatory limit, then additional soil shall be removed from that sampling location until the state of Colorado soil clean-up standard is met. The FAC may require additional or fewer samples depending on actual or changing site conditions.

Analytical results for samples collected to date from the site are presented in Tables 5-1 through 5-6. As may be seen from the data, primary constituents of concern are TPH (diesel), chromium (total), and, to a lesser extent, lead, barium, and BTEX components. Statistical analysis of the data indicate that rigorous calculations of sample population size needed to establish clean-up attainment are not possible for all COCs, particularly chromium (total) and TPH (diesel), due to the high degree of variation and nonnormal distribution of the analytical results.

Table 5-1
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 3)

Compound	Regulatory Limit	Sampling Conducted in September 1994											
		Sediment Samples											
		SD-01	Q[a]	SD-02	Q	SD-03	Q	SD-04	Q	SD-05	Q	EQ-01[c]	Q
Total Metals (mg/kg)												µg/L	
Aluminum		11,700		13,400		32,300		61,500		30,700		56.7	B
Antimony		0.72	B[a]	0.57	U[a]	0.81	U	1.5	U	3.7	U	1.8	U
Arsenic	100[b]	7.6		7.1		15.5		31.6		12.9	B	1.8	U
Barium	2,000[b]	158		179		395		1,140		816		2.2	B
Beryllium		0.79	B	0.78	B	1.8	B	4.8		2.4	B	0.39	B
Cadmium	20[b]	1.3	U	1.2	U	1.7	U	3.1	U	7.6	U	3.7	U
Calcium		18,800		17,800		16,700		53,500		37,300		26.5	B
Chromium	100[b]	20.6		29.7		55.9		**114**		**2,170**		3.4	U
Cobalt		8.3	B	8.9	B	15.8	B	34.4	B	19.1	B	3.2	U
Copper		20.5		22.1		47.7		95.8		164		7.4	B
Iron		17,900		16,100		36,300		71,300		37,200		66.1	B
Lead	100[b]	13.2		8.5		30.6		68.9		**427**		1.4	B
Magnesium		7,360		6,540		12,800		29,500		16,900		84.7	B
Manganese		243		287		670		1,460		883		2.1	B
Mercury	4[b]	0.11	B	0.08	B	0.11	U	0.42		0.90	B	0.10	U
Nickel		17.2		20.4		42.1		89.3		60.7	B	15.5	U
Potassium		2,200		1,990		3,890		12,500		8,620	B	1,940	U
Selenium	20[b]	0.50	B	0.41	U	0.59	U	1.1	U	2.7	U	1.3	U
Silver	100[b]	1.3	U	1.2	U	1.7	U	3.1	U	7.6	U	3.7	U
Sodium		820	B	505	B	852	B	5,220		1,970	B	459	B
Thallium		0.51	U	0.47	U	0.68	U	1.2	U	3.1	U	1.5	U
Vanadium		38.1		35.3		75.5		129		57.1	B	3.1	U
Zinc		58.3		49.5		103		178		191		12.5	B

Refer to footnotes at end of table.

Table 5-1
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 3)

Compound	Regulatory Limit	Sampling Conducted in September 1994											
		Sediment Samples											
		SD-01	Q[a]	SD-02	Q	SD-03	Q	SD-04	Q	SD-05	Q	EQ-01[c]	Q
TCLP Metals (mg/L)												mg/L	
Chromium	5[d]	NA[e]		NA		NA		NA		0.066		NA	
Lead	5[d]	NA		NA		NA		NA		0.042	U	NA	
TPH (mg/kg)												mg/L	
Nonspecific	250[f]	NA		15.8	U	NA		17,000		72,600		NA	
Gas		NA		NA		NA		NA		NA		NA	
Diesel		NA		NA		NA		NA		NA		NA	
Waste Oil		NA		NA		NA		NA		NA		NA	
BTEX (µg/kg)												µg/L	
Benzene	[g]	NA		NA		NA		NA		NA		NA	
Toluene	[g]	NA		NA		NA		NA		NA		NA	
Ethylbenzene	[g]	NA		NA		NA		NA		NA		NA	
Xylene	[g]	NA		NA		NA		NA		NA		NA	
Total BTEX	50,000	NA		NA		NA		NA		NA		NA	
PCB (µg/kg)												µg/L	
Aroclor-1016		NA		NA		NA		140	U	340	U	NA	
Aroclor-1221		NA		NA		NA		140	U	340	U	NA	
Aroclor-1232		NA		NA		NA		140	U	340	U	NA	
Aroclor-1242		NA		NA		NA		140	U	340	U	NA	
Aroclor-1248		NA		NA		NA		140	U	340	U	NA	
Aroclor-1254		NA		NA		NA		140	U	340	U	NA	
Aroclor-1260		NA		NA		NA		140	U	340	U	NA	

Refer to footnotes at end of table.

Table 5-1
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 3 of 3)

Compound	Regulatory Limit	Sampling Conducted in September 1994											
		Sediment Samples											
		SD-01	Q[a]	SD-02	Q	SD-03	Q	SD-04	Q	SD-05	Q	EQ-01[c]	Q
Gross Alpha/Beta (pCi/g)												pCi/L	
Gross Alpha		15.6		14.6		7.72		11.6		6.56		0.27	
2 Sigma Error (+/-)		5.0		4.9		3.74		4.5		3.58		0.16	
MDA[h]		5.0		5.0		5.18		5.3		5.23		0.21	
Gross Beta		25.8		24.4		22.4		20.6		17.4		-0.003	
2 Sigma Error (+/-)		3.9		3.7		3.4		3.3		2.9		0.046	
MDA		3.7		3.6		3.2		3.5		3.1		0.665	
Gamma Spec. (pCi/g)												pCi/L	
Cesium-137		ND[i]		ND		ND		ND		ND		ND	
Potassium-40		22.1		24.4		17.5		15.2		11.2		ND	
Lead-212		ND		1.30		ND		1.06		1.23		ND	
Radium-226		0.91		0.75		ND		ND		ND		ND	

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[c] Quality Assurance Sample
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] The sample was not analyzed for that parameter.
[f] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[g] No individual regulatory level for this parameter, it is combined as Total BTEX.
[h] Minimum Detectable Activity
[i] Nondetect means the analyte was not found in the sample at a concentration above the instrument detection limit.

mg/kg = milligram per kilogram
pCi/g = picocurie per gram
pCi/L = picocurie per liter
mg/L = milligram per liter
µg/L = microgram per liter
µg/kg = microgram per kilogram

Table 5-2
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

Compound	Regulatory Limit	Sampling Conducted in October 1994																	
		Sediment Samples																	
		SD-06	Q[a]	SD-07	Q	SD-08	Q	SD-09	Q	SD-10	Q	SD-11	Q	SD-12	Q	SD-13[b]	Q	WFR-O[c]	Q
Total Metals (mg/kg)																		µg/L	
Aluminum		7,830		1,930		2,300		3,270		3,250		4,160		1,830		2,160		37.4	B
Antimony		0.36	U	0.36	U	0.36	U	0.36	U	0.36	U	0.36	U	0.36	U	0.36	U	1.8	U
Arsenic	100[d]	3.5		0.60	B	0.97	B	0.72	B	0.56	B	2.3		1.1	B	0.69	B	1.0	U
Barium	2,000[d]	132		100		87.8		152		174		96.3		71.3		88.0		1.8	B
Beryllium		0.56	B	0.39	B	0.39	B	0.39	B	0.43	B	0.39	B	0.26	B	0.30	B	0.29	B
Cadmium	20[d]	1.1		0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	3.7	U
Calcium		16,100		5,340		5,960		7,060		6,690		13,600		6,510		5,960		130	B
Chromium	100[d]	22.3		**187**		**233**		**343**		**317**		**106**		**214**		**206**		3.5	B
Cobalt		5.0	B	1.4	B	1.6	B	2.0	B	2.6	B	1.8	B	0.84	B	1.5	B	3.2	U
Copper		17.0		9.0		10.9		13.4		9.6		11.6		7.3		10.6		10.0	B
Iron		11,700		3,410		3,980		5,560		5,000		5,380		2,670		3,570		72.2	B
Lead	100[d]	8.3		10.1		11.3		13.3		9.2		8.1		28.8		13.9		1.0	U
Magnesium		4,300		1,590		1,930		2,220		2,230		2,590		1,250		1,760		133	B
Manganese		148		79.8		115		111		99.2		81.6		74.3		106		3.6	B
Mercury	4[d]	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.16	B
Nickel		15.6		4.3	B	4.8	B	7.3	B	8.0	B	5.1	B	3.5	B	5.4	B	15.5	U
Potassium		1,560		527	B	902	B	1,350		1,420		877	B	389	U	553	B	1,940	U
Selenium	20[d]	0.28	B	0.26	U	0.26	U	0.26	U	0.26	U	0.26	U	0.26	U	0.26	U	1.3	U
Silver	100[d]	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	0.74	U	3.7	U
Sodium		368	B	264	B	218	B	1,630		973	B	351	B	233	B	288	B	181	B
Thallium		0.30	U	0.30	U	0.30	U	0.30	U	0.30	U	0.30	U	0.30	U	0.30	U	1.5	U
Vanadium		19.2		3.8	B	4.0	B	6.1	B	6.8	B	10.9		3.7	B	4.1	B	4.9	B
Zinc		36.7		21.3		22.7		29.5		23.6		23.0		14.0		20.1		7.4	B

Refer to footnotes at end of table.

Table 5-2
Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

Compound	Regulatory Limit	Sampling Conducted in October 1994 — Sediment Samples																	
		SD-06	Q[a]	SD-07	Q	SD-08	Q	SD-09	Q	SD-10	Q	SD-11	Q	SD-12	Q	SD-13[b]	Q	WFR-Q[c]	Q
TCLP Metals (mg/L)																			
Chromium	5[e]	NA[f]		NA		NA		0.44		NA		NA		NA		NA		NA	
Lead	5[e]	NA		NA		NA		NA		NA		NA		NA		NA		NA	
TPH (mg/kg)																		μg/L	
Nonspecific	250[g]	NA		NA		NA		NA		NA		NA		NA		NA		NA	
Gas		0.50	U	250		28		79		260		260		210		7.6	*	100	U
Diesel		24	U	4,800		15,000		9,600		11,000		4,400		10,000		12,000		500	U
Waste Oil		34		2,500	U	490	U	250	U	2,400	U	250	U	240	U	500	U	500	U
BTEX (μg/kg)																		μg/L	
Benzene	[h]	2.0	U	27		2.0	U	26		14		26		19		2.0	U	NA	
Toluene	[h]	2.0	U	690		9.5		660		700		310		370		31		NA	
Ethylbenzene	[h]	2.0	U	980		29		880		990		890		1,200		62		NA	
Xylene	[h]	2.0	U	4,300		160		3,800		4,400		4,100		5,200		300		NA	
Total BTEX	50,000		U	5,997		200.5		5,366		6,104		5,326		6,789		395		NA	

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate sample of SD-08
[c] Quality Assurance Sample
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] The sample was not analyzed for that parameter.
[g] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

*Value outside of QA limits

mg/kg = milligram per kilogram
μg/kg = microgram per kilogram
mg/L = milligram per liter
μg/L = microgram per liter

Table 5-3
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

Compound	Regulatory Limit	Analytical Results for Sampling Conducted in April 1995 — Sediment Samples																	
		SD-14	Q[a]	SD-15	Q	SD-16	Q	SD-17	Q	SD-18	Q	SD-19[b]	Q	ST-01	Q	WFR-04[c]	Q	WFR-04[c]	Q
Total Metals (mg/kg)																**Dissolved Metals µg/L**		**Total Metals µg/L**	
Aluminum		14,200		11,400		2,540		14,900		3,250		40		Na[g]		47.5	B	58.5	B
Antimony		0.38	B[a]	0.32	U[a]	0.32	U	0.32	U	0.32	U	0.32	U	NA		9.4	B	1.6	U
Arsenic	100[d]	9.9		7.6		0.41	B	12.1		0.52	B	0.72	B	NA		1.1	U	1.1	U
Barium	2,000[d]	219		161		128		195		136		113		NA		3.4	B	3.8	B
Beryllium		0.86	B	0.72	B	0.32	B	0.93	B	0.48	B	0.31	B	NA		0.90	U	0.90	U
Cadmium	20[d]	0.52	U	0.67	B	0.52	U	0.52	U	0.52	U	0.52	U	NA		2.6	U	2.6	U
Calcium		4,150		4,940		5,780		13,600		8,390		5,710		NA		2050	B	1790	B
Chromium	100[d]	30.6		22.4		298		26.8		34.5		307		NA		5.0	U	5.0	U
Cobalt		8.3	B	6.7	B	1.4	B	8.0	B	2.4	B	1.3	B	NA		4.4	U	4.4	U
Copper		20.4		17.2		10.8		29.6		11.2		8.5		NA		7.3	U	9.8	U
Iron		20,000		16,000		4,240		18,900		5,240		3,350		NA		65.3	B	38.9	U
Lead	100[d]	13.6		11.9		9.2		12.4		8.5		8.7		NA		1.1	U	1.1	U
Magnesium		5,880		4,890		1,780		7,220		2,550		1,580		NA		359	B	367	B
Manganese		416		430		94.5		374		128		79.9		NA		5.3	B	2.1	U
Mercury	4[d]	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	0.05	U	NA		0.10	U	0.10	U
Nickel		27.6		17.5		4.8	B	26.2		8.4		4.6	B	NA		7.9	U	15.4	U
Potassium		1,390		1,740		1,030		1,980		960	B	662	B	NA		347	U	1180	U
Selenium	20[d]	0.22	U	0.22	U	0.22	U	0.22	U	0.22	U	0.22	U	NA		1.1	U	1.1	U
Silver	100[d]	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	1.1	U	NA		5.5	U	5.5	U
Sodium		275	B	426	B	1,120		576	B	1,110		690	B	NA		728	B	397	B
Thallium		0.37	B	0.22	U	0.22	U	0.22	U	0.22	U	0.22	U	NA		1.1	U	1.1	U
Vanadium		35.7		26.4		5.0	B	32.5		7.9	B	5.3	B	NA		15.5	U	15.5	U
Zinc		50.2		51.2		22.7		57.4		26.2		18.1		NA		85.6		13.8	B

Refer to footnotes at end of table.

Table 5-3
Sediment Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

Compound	Regulatory Limit	Analytical Results for Sampling Conducted in April 1995 — Sediment Samples																	
		SD-14	Q[a]	SD-15	Q	SD-16	Q	SD-17	Q	SD-18	Q	SD-19[b]	Q	ST-01	Q	WFR-04[c]	Q	WFR-04[c]	Q
TCLP Metals mg/L																			
Arsenic	5.0[e]	0.035	U	0.035	U	0.035	U	0.035	U	0.035	U	0.035	U	NA		NA		NA	
Barium	100[e]	0.76		0.49		0.92		0.44		0.88		1.1		NA		NA		NA	
Cadmium	1.0[e]	0.0024	U	0.0024	U	0.0024	U	0.0024	U	0.0024	U	0.0024	U	NA		NA		NA	
Chromium	5.0[e]	0.0080	B	0.0047	U	0.23		0.0047	U	0.026		0.17		NA		NA		NA	
Lead	5.0[e]	0.028	U	0.028	U	0.029	B	0.028	U	0.028	U	0.028	U	NA		NA		NA	
Mercury	0.2[e]	0.00019	B	0.00010	U	0.00010	U	0.00010	U	0.00010	U	0.00020		NA		NA		NA	
Selenium	1.0[e]	0.038	U	0.038	U	0.38	U	0.038	U	0.038	U	0.038	U	NA		NA		NA	
Silver	5.0[e]	0.0047	B	0.0041	U	0.0041	U	0.0041	U	0.0041	U	0.0041	U	NA		NA		NA	
TPH mg/kg																			
Diesel	[f]	NA		NA		NA		NA		NA		NA		25	U	NA		NA	
Waste Oil	[f]	NA		NA		NA		NA		NA		NA		25	U	NA		NA	
BTEX mg/kg																µg/L			
Benzene	[h]	NA		NA		NA		NA		NA		NA		2.0	U	2.0	U	2.0	U
Toluene	[h]	NA		NA		NA		NA		NA		NA		2.0	U	2.0	U	2.0	U
Ethylbenzene	[h]	NA		NA		NA		NA		NA		NA		2.0	U	2.0	U	2.0	U
Xylene	[h]	NA		NA		NA		NA		NA		NA		4.0	U	4.0	U	4.0	U

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate sample of SD-18
[c] Quality Assurance Sample
[d] *No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."* Regulatory limits are based on 20X the RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] Regulatory limits for these parameters specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." *Regulatory limits are based on* RCRA "Maximum Concentration of Contaminants for the Toxicity Characteristic."
[g] The sample was not analyzed for that parameter.
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

mg/kg = milligram per kilogram
µg/kg = microgram per kilogram
mg/L = milligram per liter
µg/L = microgram per liter

Table 5-4
Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 3)

Compound	Regulatory Limit	Soil Samples Collected Sept. and Oct. 1994						Soil Samples Collected in April 1995						Field Rinsate	
		SS-01	Q[a]	SS-02	Q	SS-03	Q	SS-04	Q	SS-05[b]	Q	SS-06	Q	WFR-03[c]	Q
Total Metals (mg/kg)														µg/L	
Aluminum		7,300		6,320		13,000		5,940		3,710		11,000		26.2	B
Antimony		0.36	U[a]	0.36	U	0.45	B[a]	0.32	U	0.32	U	0.32	U	1.8	U
Arsenic	100[d]	5.4		2.4		15		2.6		2	B	6.2		1	U
Barium	2,000[d]	**2,530**		**6,040**		206		**6,870**		**5,000**		895		2.1	B
Beryllium		0.65	B	0.71	B	0.82	B	0.63	B	0.55	B	0.71	B	0.2	U
Cadmium	20[d]	0.74	U	0.74	U	0.86	B	0.71	B	0.52	U	0.52	U	3.7	U
Calcium		4,950		10,600		6,270		6,950		7,130		4,640		115	B
Chromium	100[d]	**467**		**857**		25.5		**779**		**750**		**112**		3.4	U
Cobalt		6.5	B	9.3	B	8.2	B	10.2		7.4	B	7.4	B	3.2	U
Copper		19.7		26.1		18.5		23.4		21.5		15.2		9.3	B
Iron		12,300		12,500		20,200		11,500		9,250		16,200		110	
Lead	100[d]	47.6		84		18.8		86.3		77.8		18.3		1	U
Magnesium		3,230		3,550		6,540		2,920		2,220		4,040		113	B
Manganese		294		279		445		286		218		272		1.8	B
Mercury	4[d]	0.05	U	0.06	B	0.05	B	0.05	U	0.05	U	0.05	U	0.16	B
Nickel		14.4		11.3		19.4		11.5		9.1		16.1		15.5	U
Potassium		1,560		2,400		1,560		1,730		1,400		2,260		1,940	U
Selenium	20[d]	0.26	U	0.26	U	0.26	U	0.22	U	0.22	U	0.22	U	1.3	U
Silver	100[d]	0.74	U	0.74	U	0.74	U	1.1	U	1.1	U	1.1	U	3.7	U
Sodium		2,020		1,080		774	B	208	B	279	B	109	B	250	B
Thallium		0.3	U	0.3	U	0.33	B	0.22	U	0.22	U	0.22	U	1.5	U
Vanadium		14.2		9.4	B	36.3		10		5.9	B	22.3		5.6	B
Zinc		135		245		54.1		243		221		67.6		19.7	B

Refer to footnotes at end of table.

Table 5-4
Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 3)

Compound	Regulatory Limit	Soil Samples Collected Sept. and Oct. 1994						Soil Samples Collected in April 1995						Field Rinsate	
		SS-01	Q[a]	SS-02	Q	SS-03	Q	SS-04	Q	SS-05[b]	Q	SS-06	Q	WFR-03[c]	Q
TCLP Metals (mg/L)															
Arsenic	5[e]	NA[f]		NA		NA		0.035	U	0.035	U	0.035	U	NA	
Barium	10[e]	NA		NA		NA		1		0.87		0.62		NA	
Cadmium	1[e]	NA		NA		NA		0.0024	U	0.0024	U	0.002	U	NA	
Chromium	5[e]	NA		0.22		NA		0.05		0.12		0.005	B	NA	
Lead	5[e]	NA		0.042	U	NA		0.028	U	0.039	B	0.028	U	NA	
Selenium	1[e]	NA		NA		NA		0.038	U	0.038	U	0.038	U	NA	
Silver	5[e]	NA		NA		NA		0.0041	U	0.0041	U	0.004	U	NA	
Mercury	0.20[e]	NA		NA		NA		0.00010	U	0.00014	B	0.0001	U	NA	
TPH (mg/kg)														**ug/L**	
Nonspecific	250[g]	NA		NA		NA		NA		NA		NA		NA	
Gas		16		75	*	0.83	*	NA		NA		NA		100	U
Diesel		12,000		73,000		25	U	NA		NA		NA		500	U
Waste Oil		250	U	2,500	U	54		NA		NA		NA		500	U

Refer to footnotes at end of table.

Table 5-4
Soil Sampling Results for Rulison Drilling Effluent Pond
(Page 3 of 3)

Compound	Regulatory Limit	Soil Samples Collected Sept. and Oct. 1994						Soil Samples Collected in April 1995						Field Rinsate	
		SS-01	Q[a]	SS-02	Q	SS-03	Q	SS-04	Q	SS-05[b]	Q	SS-06	Q	WFR-03[c]	Q
BTEX (µg/kg)														ug/L	
Benzene	h	4.9		38		2	U	NA		NA		NA		NA	
Toluene	h	17		570		2	U	NA		NA		NA		NA	
Ethylbenzene	h	120		570		2	U	NA		NA		NA		NA	
Xylene	h	500		2,800		2	U	NA		NA		NA		NA	
Total BTEX	50,000	641.9		3,978		2	U	NA		NA		NA		NA	

[a] Q = Laboratory assigned data qualifier: U = Compound was analyzed but not detected; B = In organics, the analyte was found in the blank. In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b] Duplicate of Sample SS-04
[c] Field Rinsate taken during October 1994 sampling event
[d] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on 20X RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic."
[e] No regulations for these soil parameters are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Regulatory limits are based on RCRA Maximum Concentration of Contaminants for the Toxicity Characteristic."
[f] The sample was not analyzed for that parameter.
[g] This limit is based on regulations specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document."
[h] No individual regulatory level for this parameter, it is combined as Total BTEX.

* Value outside of QA limits

mg/kg = milligram per kilogram µg/kg = microgram per kilogram
mg/L = milligram per liter µgL = microgram per liter

Table 5-5
Surface Water Sampling Results for Rulison Drilling Effluent Pond
(Page 1 of 2)

Compound	Regulatory Limit[a]	Sampling Conducted in Sept. and Oct. 1994 — Pond Surface Water Samples								Sampling Conducted in April 1995 — Stream		Spring		Stream		Spring		Sampling Conducted in April 1995 — Pond Surface Water Samples								October 1994 Rinsate Samples		April 1995 Rinsate Samples	
		SW-01	Q[b]	SW-02	Q	SW-03	Q	SW-04	Q	SWST-01	Q	SWS-01	Q	SWST-01	Q	SWS-01	Q	SWP-01	Q	SWP-02	Q	SWP-03*	Q	SWP-04	Q	WFR-01	Q	WF-04	Q
Total Metals (µg/l)										**Total Metals (µg/l)**				**Dissolved Metals (µg/l)**															
Aluminum		52.4	B[b]	135	B	43.2	B	77.2	B	228		32.5	U	34.1	B	55.6	B	NA[c]		NA		NA		NA		27.5	B	NA	
Antimony		1.8	U[b]	1.8	U	1.8	U	1.8	U	1.6	U	3.3	B	3.2	B	6	B	NA		NA		NA		NA		1.8	U	NA	
Arsenic	50	7.4	B	7.5	B	7	B	7.4	B	1.3	B	1.1	U	1.1	U	1.1	U	NA		NA		NA		NA		1	U	NA	
Barium	1,000	51.2	B	52.8	B	49.8	B	51.9	B	52.8	B	46.4	B	47.9	B	45.8	B	NA		NA		NA		NA		1.8	B	NA	
Beryllium		0.86	B	0.29	B	0.29	B	0.29	B	1.7	B	0.9	U	0.9	U	1.4	B	NA		NA		NA		NA		0.21	B	NA	
Cadmium	10	3.7	U	3.7	U	3.7	U	3.7	U	2.6	B	2.6	U	2.6	U	2.6	U	NA		NA		NA		NA		3.7	U	NA	
Calcium		23,400		23,800		22,900		23,500		43,300		83,100		42,600		82,000		NA		NA		NA		NA		90.4	B	NA	
Chromium	50	3.4	U	3.4	U	3.4	U	3.9	B	5	U	5	U	5	U	5	U	NA		NA		NA		NA		3.4	U	NA	
Cobalt		3.2	U	3.2	U	3.2	U	3.2	U	4.4	U	4.4	U	4.4	U	4.4	U	NA		NA		NA		NA		3.2	U	NA	
Copper		10.7	B	12.5	B	8.5	B	16.9	B	10.6	B	9.8	U	7.3	U	8.8	B	NA		NA		NA		NA		9.3	B	NA	
Iron		62.2	B	201		61	B	177		239		38.9	U	38.9	U	38.9	U	NA		NA		NA		NA		46	B	NA	
Lead	50	1	U	1	U	1	U	1	U	1.1	U	1.1	U	1.1	U	1.1	U	NA		NA		NA		NA		1	U	NA	
Magnesium		28,900		29,200		28,700		29,400		15,300		58,100		15,200		56,400		NA		NA		NA		NA		135	B	NA	
Manganese		6	B	18.9		5.5	B	8.3	B	12.9	B	2.1	U	2.7	B	2.1	U	NA		NA		NA		NA		2.9	B	NA	
Mercury	2	0.14	B	0.16	B	0.16	B	0.16	B	0.1	U	0.1	U	0.1	U	0.1	U	NA		NA		NA		NA		0.16	B	NA	
Nickel		15.5	U	15.5	U	15.5	U	15.5	U	15.4	U	15.4	U	7.9	U	7.9	U	NA		NA		NA		NA		15.5	U	NA	
Potassium		2,030	B	1,940	U	1,940	U	1,940	U	1,860	B	1,180	U	1,890	B	1,240	B	NA		NA		NA		NA		1,940	U	NA	
Selenium	10	6.5	U	6.5	U	6.5	U	6.5	U	1.5	B	2.1	B	1.1	U	2.7	B	NA		NA		NA		NA		1.3	U	NA	
Silver	50	3.7	U	3.7	U	3.7	U	3.7	U	5.5	U	5.5	U	5.5	U	5.5	U	NA		NA		NA		NA		3.7	U	NA	
Sodium		51,400		52,500		51,700		52,300		18,900		52,800		19,900		50,600		NA		NA		NA		NA		183	B	NA	
Thallium		1.5	U	1.5	U	1.5	U	1.5	U	1.1	U	1.1	U	1.1	U	1.1	U	NA		NA		NA		NA		1.5	U	NA	
Vanadium		11	B	11	B	9.7	B	10.5	B	15.5	U	15.5	U	15.5	U	15.5	U	NA		NA		NA		NA		4	B	NA	
Zinc		9.4	B	14.2	B	11.1	B	11.3	B	13.2	B	10.3	B	10.2	B	9.6	B	NA		NA		NA		NA		7.3	B	NA	
TPH[d] (mg/l)																													
Nonspecific		0.48	U	0.51	U	0.48	U	0.56	U	NA		NA		NA		NA		NA		NA		NA		NA		0.49	U	NA	
Gas		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Diesel		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Waste Oil		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	

Refer to footnotes at end of table.

Table 5-5
Surface Water Sampling Results for Rulison Drilling Effluent Pond
(Page 2 of 2)

Compound	Regulatory Limit[a]	Sampling Conducted in Sept. and Oct. 1994 — Pond Surface Water Samples								Sampling Conducted in April 1995 — Stream		Spring		Stream		Spring		Sampling Conducted in April 1995 — Pond Surface Water Samples								October 1994 — Rinsate Samples		April 1995 — Rinsate Samples	
		SW-01	Q[b]	SW-02	Q	SW-03	Q	SW-04	Q	SWST-01	Q	SWS-01	Q	SWST-01	Q	SWS-01	Q	SWP-01	Q	SWP-02	Q	SWP-03*	Q	SWP-04	Q	WFR-01	Q	WF-04	Q
Tritium (pCi/l)														**	**	**	**												
Tritium		-2		40		78		70		NA		NA		**	**	**	**	NA		NA		NA		NA		-2		NA	
2 Sigma Error (+/-)		103		105		106		106		NA		NA		**	**	**	**	NA		NA		NA		NA		103		NA	
MDA		178		178		178		178		NA		NA		**	**	**	**	NA		NA		NA		NA		178		NA	
BTEX[e] (ug/kg)																													
Benzene	5[f]	NA		NA		NA		NA		2	U	2	U	**	**	**	**	2	U	2	U	2	U	2	U	NA		2	U
Toluene	1,000	NA		NA		NA		NA		2	U	2	U	**	**	**	**	2	U	2	U	2	U	2	U	NA		2	U
Ethylbenzene	680	NA		NA		NA		NA		2	U	2	U	**	**	**	**	2	U	2	U	2	U	2	U	NA		2	U
Xylene	10,000	NA		NA		NA		NA		4	U	4	U	**	**	**	**	4	U	4	U	4	U	4	U	NA		4	U

[a]No regulations for metal concentrations, Total Petroleum Hydrocarbon and Radionuclides are specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Document." Colorado water clean-up standards are site specific and based on "The Basic Standards for Groundwater (5CCR1002-8)." The Safe Drinking Water Standards have been provided for comparison purposes only.
[b]Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[c]The sample was not analyzed for that parameter.
[d]Total Petroleum Hydrocarbons
[e]Benzene, Toluene, Ethylbenzene, Xylene
[f]This limit is based on regulation specified in the Colorado Department of Health "Storage Tank Facility Owner/Operator Guidance Documents."

*Duplicate of sample SWP-02
**These samples were not analyzed for these parameters.

mg/kg = milligram per kilogram
μg/kg = microgram per kilogram
μg/l = microgram per liter

Table 5-6
Fish Sampling Results for Rulison Drilling Effluent Pond

Compound	Sampling Conducted in September and October 1994							
	F-01	Q[a]	F-02	Q	F-03	Q	WFB-01[b]	Q
Metals (mg/kg)							mg/L	
Aluminum	6.40	B[a]	5	U[a]	5	U	59.9	B
Antimony	0.36	U	0.36	U	0.36	U	1.8	U
Arsenic	0.26	U	0.26	U	0.43	B	1.0	U
Barium	0.31	B	0.21	B	0.16	B	1.4	B
Beryllium	0.04	B	0.04	U	0.04	U	0.29	B
Cadmium	0.74	U	0.74	U	0.74	U	3.7	U
Calcium	369	B	426	B	453	B	69.2	B
Chromium	0.68	U	0.68	U	0.68	U	3.4	U
Cobalt	0.64	U	0.64	U	0.64	U	3.2	U
Copper	0.77	B	0.5	U	0.5	U	8.4	B
Iron	12.6	B	11.1	B	5.7	B	71.0	B
Lead	0.2	U	2	U	2	U	1.0	U
Magnesium	259	B	233	B	284	B	155	B
Manganese	0.14	U	0.14	B	0.14	U	1.7	B
Mercury	0.13		0.05	B	0.08	B	0.15	B
Nickel	3.1	U	3.1	U	3.1	U	15.5	U
Potassium	4,870		3,880		4,490		1,940	U
Selenium	0.26	U	0.26	U	0.26	U	1.3	U
Silver	0.74	U	0.74	U	0.74	U	3.7	U
Sodium	609	B	693	B	780	B	168	B
Sodium	0.3	U	0.3	U	0.3	U	1.5	U
Vanadium	0.62	U	0.62	U	0.62	U	4.9	B
Zinc	6.2		6.3		9.1		13.5	B
TPH (mg/kg)[c]								
Nonspecific	13.7		31.5		17.3		0.49	U
Gas	NA[d]		NA		NA		NA	
Diesel	NA		NA		NA		NA	
Waste Oil	NA		NA		NA		NA	

[a]Q = Laboratory assigned data qualifier: U = Compound was analyzed for but not detected; B = In inorganics, the result is above the Instrument Detection Limit but below the Contract Required Detection Limit.
[b]Field blank sample
[c]Total Petroleum Hydrocarbons
[d]The sample was not analyzed for that parameter.

mg/kg = milligram per kilogram
mg/L = milligram per liter

Sample population size has been determined through the use of power curves, presented in the 1989 EPA guidance document "Methods for Evaluating the Attainment of Cleanup Standards, Volume 1: Soils and Solid Media" (EPA, 1989a) for testing the mean in determining the attainment of clean-up standards. The sample population size was determined for TPH, as this COC has the greatest likelihood of requiring additional samples to demonstrate clean-up attainment. For the purposes of this test, the following assumptions were made:

$$\alpha = 10\%$$
$$\beta = 20\%$$
$$\mu_1 = 0.46 \cdot Cs$$
$$Cs = 250 \text{ milligrams per kilogram TPH}$$
$$cv = 1.29$$

where

α	=	false positive rate (i.e., site is thought to be clean but is not)
β	=	false negative rate (i.e., site is thought to be contaminated but is not)
μ_1	=	mean analytical result desired is determined from the associated power curve corresponding to the given α and β
Cs	=	clean-up standard
cv	=	coefficient of variation for the data as the ratio of the standard deviation to the mean.

Using the power curve "C" for $\alpha = 10\%$, and estimating the cv for the currently existing data at a desired mean of 46 percent of the Colorado clean-up standard for TPH, the estimated number (n_d) of samples to be collected to determine if clean-up standards have been met is 35 TPH samples.

Using the number of samples obtained above, the final sample size is determined by the following:

$$n_f = n_d / (1 - R)$$

where

n_d	=	estimated sample size (35)
R	=	rate that missing or unusable data will occur (1% unusable)
n_f	=	final sample size

Thus, the total number of TPH samples to collect is estimated at 36.

The sample grid is calculated from the following equation:

$$L = (A / n_f)^{1/2}$$

where

L	=	distance between sample points (in m)
A	=	total area (in m^2) to be sampled (2,024 m^2)
n_f	=	sample size (36)

Thus, the distance between sampling points on the sampling grid is estimated to be 7.5 m. Based on a total of 36 TPH samples, 36 BTEX samples and 8 total RCRA metals samples will be collected. Total metals sample locations will be chosen randomly from the nodes on the grid, using a random numbers table. An additional verification soil sample will be collected from the settling area located on the west side of the drilling effluent pond. A diagram showing the proposed layout for verification soil samples is included as Figure 5-1.

5.6 Sampling and Sample Handling Procedures

Prior to beginning sampling activities, all required permits and/or written approvals will be obtained and all required materials and equipment will be staged at the site. The Environmental Services Support Contractor shall verbally notify the persons granting authorization to sample the site prior to sampling activities.

An SSHASP shall also be prepared and approved prior to initiating sampling activities. All sampling activities will be conducted in accordance with an approved SSHASP. Any basic protective clothing or equipment required for sampling will be specified in the SSHASP. Procedures and requirements for sample collection, preservation, handling, and analysis are detailed below.

5.7 Sample Collection

Sampling will be conducted in accordance with approved contractor procedures. A sampling grid will be constructed at the sampling sites based on the calculations presented in Section 5.1.4 of this VSAP. One TPH and BTEX environmental sample will be collected at each of the sampling nodes on the grid. Eight total RCRA metals samples will be collected from randomly chosen nodes on the sampling grid. Additionally, one MS/MSD sample and one duplicate sample will be collected from randomly chosen locations and intervals along the grid, at rates

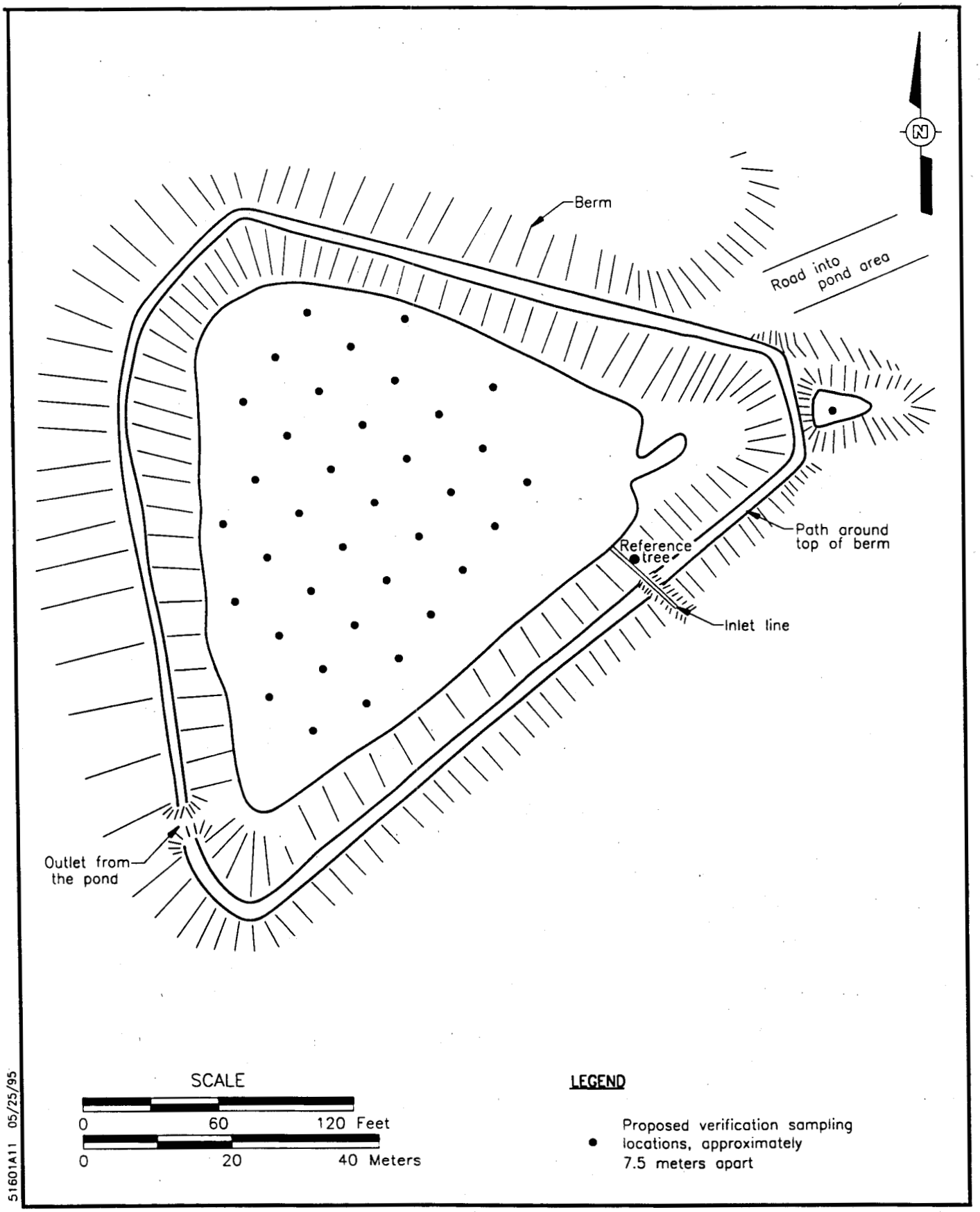

Figure 5-1
Proposed Verification Soil Sampling Locations,
Rulison Drilling Effluent Pond

indicated in Chapter 4.0 of this VSAP. The MS/MSD and duplicate samples will not be collected from the same location/interval as one another. The QC samples will be split (collected from) the same volume of sediment from which the associated environmental sample was taken. A detailed geologic description will be made of every environmental sample collected.

To achieve unbiased sample splits, each sample volume will be homogenized in a decontaminated stainless-steel mixing bowl, using a stainless-steel trowel or spatula, prior to splitting the sample fractions. Samples for BTEX will not be homogenized. Equipment rinsate samples will be collected at rates specified in Chapter 4.0 of this VSAP, and source water blank samples will be collected during the execution of this plan. Liquid samples (equipment rinsate and deionized water field blanks) will consist of one 1-liter polyethylene-bottle for metals analysis, and three 40-mℓ glass VOA-vials for BTEX analysis. One 500-mℓ TPH and one 250-mℓ amber glass shall be collected from each soil sample location. One 500-mℓ amber glass for metals analysis will be collected from the 8 randomly-chosen nodes on the grid.

Soil samples shall be collected following the procedures listed below:

- Construct the sampling grid according to the calculations presented above. If no sampling grid is possible because of sediment clean-up operations, each sampling location will be identified and located at the approximate distance form each neighbor sampling location as the cleanup progresses.

- Don clean, dry, surgical gloves prior to beginning sampling activities. Cotton gloves may be worn underneath the surgical gloves. Surgical gloves will be replaced after each discreet sample is collected.

- After sampling activities at a given sampling location are completed, documented, and verified, fill in the hole with excess excavated sediment (if necessary). Prior to sampling the next location, decontaminate the sampling tools according to approved contractor procedures.

- Perform a final decontamination of the sampling and mixing equipment using the same decontamination procedure (Section 5.4). Collect a single equipment rinsate sample by pouring deionized water over the sampling device and collecting the sample directly from the stream of water coming off the device. Also, collect an aliquot of each source of deionized water used for the equipment rinsate sample and the decontamination activities. Containerize the decontamination water for later disposal.

- Prior to leaving the site, survey the area to be sure that it is left in its original condition and that no materials or wastes are left behind.

5.8 Sample Preservation

All samples will be preserved by cooling to approximately 4 degrees Celsius (°C). Samples will be placed in a shipping cooler with frozen cooling gel packs and/or ice at the site. The target temperature of 4°C ± 2°C will be maintained until the laboratory receives the shipment. The temperature of the water shall be assessed upon arrival to the laboratory. Equipment rinsate and deionized-water blank for metals analysis also include a chemical preservative as specified in the Rulison Site QAPP (DOE, 1995b).

5.9 Sample Handling and Analysis

The Rulison Site QAPP (DOE, 1995b) lists analyses, sample containers, preservatives, holding times, quantitation limits, and analytical and laboratory methods expected for this task. Analyses of all metals and organic compounds will be consistent with EPA SW-846 methodologies to provide consistent and reliable data.

All holding times, quantitation limits, critical levels, and decision amounts will be met as outlined in the Rulison Site QAPP (DOE, 1995b). Failure to meet the recommended holding times, quantitation limits, critical levels, and decision amounts may result in qualified or unacceptable data.

5.10 Decontamination Procedures

The analytical laboratory selected will supply sample containers to the field sampling personnel in a precleaned condition. Sample jar cleaning will follow established EPA guidance. In the event that the analytical laboratory cannot supply the required sample containers, containers will be purchased by the ESSC from a qualified supplier who will perform and document the sample container precleaning. Certificates of cleanliness shall be supplied for all precleaned sample containers.

Decontamination of field sampling equipment is required for all sampling tasks. A thorough decontamination of the sampling and sample mixing equipment will be performed between sampling locations at a given site using a clean scrub brush, a laboratory-grade soap (such as Alconox®) wash, isopropanol or nitric acid rinse, and a deionized water rinse. All decontamination activities performed during soil or water sampling shall be performed in accordance with approved contractor procedures.

5.11 Waste and Contaminated Materials Disposal

No investigation-derived waste will be left on site as a result of the sampling activities. Excess soil from the sampling process will be returned to its original location. Equipment rinsate and

decontamination solutions will be stored in appropriate waste containers and disposed in an appropriate fashion consistent with waste disposal guidelines.

6.0 Sample Documentation and Custody

Samples will be properly handled in accordance with approved contractor procedures to maintain sample integrity from collection through analysis. The following sections identify actual sample management and custody requirements for the study. Any significant change or nonconformance in technical procedure shall warrant official documentation.

6.1 Field Operations

To document the integrity of samples from the time of collection through data reporting, sample collection and custody records shall be maintained. Standardized forms (including Sample Collection Logs and the AR/COC) will be used to document sample collection and sample custody during field investigations. These forms will be completed using approved contractor procedures. The sampling grid locations will be clearly documented using detailed narrative and field sketches drawn on attachments to the Sample Collection Log. A detailed geologic description of the soil shall be recorded on a Field Activity Daily Log at each sampling location.

All documentation must be legible, identifiable, and recorded in permanent black ink. Field personnel will complete field documentation at the job site during or immediately after sample collection. Errors on forms are corrected by drawing a single line through the error, so that the stricken text remains legible. The correct information will be entered along with the date and initials of the person recording the information. All entries on the forms will be completed. In the event that the entry is not applicable, it will be noted by marking "NA" or by lining out the entry. Each component of the sample control and documentation process is briefly described below.

All sample documentation, including sample labels, sample collection logs, and analysis requests and chain-of-custody records, will be collected in accordance with approved contractor procedures.

6.2 Sample Identification Numbers

Each sample will be uniquely identified with an identification number issued by the ESSC Project Manager. Sample codes for grid locations or water sample collection locations may be recorded on the Sample Collection Log and AR/COC, if necessary.

6.3 Laboratory Operations

Laboratory sample custody, sample analysis, data management, reporting, and sample disposal will be performed in accordance with established laboratory procedures approved by the ESSC Project Manager.

7.0 Analytical Procedures

Analytical procedures will follow established laboratory procedures based on the referenced EPA methods. Analyses, sample containers, preservatives, holding times, quantitation limits, and analytical and laboratory methods to be used in this task are cited in the Rulison Site QAPP (DOE, 1995b).

Instrument calibration, calibration source traceability, analytical QC, and QC acceptance criteria will be in accordance with the contractor laboratory's quality assurance plan, approved by the ESSC Project Manager, and in the contract Statement of Work between the DOE and the laboratory.

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8.0 Data Reduction, Validation and Reporting

The assigned contractor analytical laboratory will perform initial data reduction and validation. Data reported by the laboratory will meet method and laboratory QC requirements. The laboratory will analyze duplicate laboratory control samples for indicators of bias and precision and will report results as percent recovery and relative percent difference of the samples and the duplicate samples. The analytical report will include the QC acceptance criteria for bias and precision (see Section 4.2 of this VSAP). The laboratory will provide a summary data report and will archive all raw data, bench sheets, and other relevant information in a retrievable manner until requested by the DOE.

8.1 Measurement Data and Sample Collection Documentation Review

The ESSC will verify sampling and analytical data generated under this VSAP for analytical contract compliance, including review of analyte quantitation (reporting) limits and QC indicators. The ESSC Project Manager will provide documentation of the verification process with transmittal of the verified data package and the final report. Data will be verified as set forth in approved contractor procedures.

8.2 Data Assessment

Following receipt of validated and verified analytical and sampling data, the ESSC Project Manager will assess the analytical results for COC detection criteria.

8.3 Data Reporting

The contractor laboratory will transmit summary analytical and laboratory QC data to the ESSC. The analytical report will be in electronic and hardcopy formats, generated from a single source. The analytical laboratory will archive all raw data, notes, and bench sheets until those records are requested by the DOE. The ESSC Project Manager will transmit all original field and sample custody documentation, verification and validation documentation, and the analytical report to the DOE/NV Rulison Site Manager as part of the report. The ESSC will prepare a report presenting the data in tabulated form to the DOE/NV Rulison Site Manager.

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9.0 Quality Reports to Management

The ESSC report will identify areas of concern encountered during project sampling and analysis efforts, as well as possible resolutions in an effort to improve data quality in future similar projects. Additional quality reports to management will include nonconformance and corrective actions and assessment results, if necessary.

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10.0 Nonconformances and Corrective Actions

Nonconformances are items or activities that do not meet the project requirements of approved procedures. Unlike variances, which are preapproved and controlled, they are uncontrolled and unapproved deviations. Nonconformances to the activities specified in this VSAP will be documented and evaluated in accordance with the Rulison Site QAPP.

Whenever possible, corrective actions will be applied to rectify or prevent reoccurrence of nonconformances or other conditions that could adversely affect the quality project data. Corrective actions will be implemented in accordance with approved contractor procedures.

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11.0 Assessments

Following approved contractor procedures, the ESSC Project and the ESSC Health and Safety Officer will conduct assessments of the sampling activities. Field assessments are used to determine if field procedures are being conducted in compliance with the applicable VSAP and SSHASP. Items reviewed may include, but are not limited to, sample collection and handling, documentation, sampling technique, equipment calibration, maintenance procedures, and health and safety practices.

The contractor's analytical laboratories participate in system audits as part of the procurement selection process. Additionally, the contractor's laboratories are required to participate in external performance audits or evaluation programs sponsored by the EPA or other state accreditation organizations.

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12.0 Records Management

Completed records generated during sampling and analysis will be submitted by the ESSC Project Manager to the DOE/NV Rulison Site Manager for archival at the DOE/NV. The DOE/NV Rulison Site Manager responsible for this task will submit all documentation to the DOE/NV records center upon completion of the project.

The laboratory shall retain and make available for inspection upon request all raw analytical records generated in conjunction with this VSAP. These records shall include instrument tuning and calibration records, batch QC sample data, control charts and calculations, sample tracking and control documentation, raw analytical sample data, and analytical results. These records shall be retained for a duration of time specified in the contract Statement of Work until requested by the DOE.

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13.0 References

EPA, See U.S. Environmental Protection Agency.

ERDA, See U.S. Energy Research and Development Administration

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